25. (Amended) The apparatus of claim 24, further comprising a memory device coupled to at least one of the first, second and third detectors to store the signal generated by the at least one detector.

26. (Amended) The apparatus of claim 24, further comprising a display coupled to at least one of the first, second and third detectors to graphically display a strength of the first and second electron flows as a function of the movement detected by the third detector.

27. (Amended) The apparatus of claim 24, further comprising a printing device coupled to at least one of the first, second and third detectors to print a representation of a strength of the first and second flows of electrons as a function of the movement detected by the third detector.

REMARKS

Claims 1-27 are currently pending in the application. In the Office Action dated August 15, 2001, claims 6-8, 17-19 and 25-27 were rejected under 35. U.S.C. § 112, second paragraph, for insufficient antecedent basis for the limitation "the detector(s)". Claims 1-4, 9-15 and 20-23 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,114,695 to Todokoro *et al.* in view of U.S. Patent No. 6,075,373 to Iino. Claims 5-8, 16-19, and 24-27 were rejected as being unpatentable over Todokoro *et al.* in view of "The S-8000 Series CD-Measurement SEM and Applications," *Hitachi Scientific Instrument Technical Data-SEM,* No.67, front cover, p.2, back cover, 1995.

Applicants disagree with these rejections under § 103 and wish to clarify various distinctions over the cited art. Reconsideration of the application is therefore requested in light of the present amendment and following remarks.

The disclosed embodiments of the invention will now be discussed in comparison to the prior art. Of course, the discussion of the disclosed embodiments, and the discussion of the differences between the disclosed embodiments and the prior art subject matter, do not define

the scope or interpretation of any of the claims. Instead, such discussed differences merely help the Examiner appreciate important claim distinction discussed thereafter.

Applicants disclose apparatus and methods for determining the dimensions of topographical surface features on a semiconductor device by using scanning electron microscope data obtained from electron beams that scan the <u>*surface*</u> of the device at two or more depths of focus, *i.e., at a first depth of focus and a second depth of focus*. The apparatus may use a primary electron beam focused first at one depth and then at a second depth, or may use two separate primary beams focused a different depths. The primary electron beams strike the *surface* of the device and a signal is detected corresponding to secondary electrons reflected or emitted form the *surfaces* at the first and second depths of focus.

A first series of electrical signals is generated corresponding to a pattern of light and dark regions (see Figure 2B) observed when secondary electrons are detected from the surface of the device scanned at the first depth of focus (see Figures 2C-2D). A second series of signals corresponding to the pattern of light dark regions observed upon scanning at the second depth of focus is also generated (see Figure 2E-2F). The first signal pattern may be compared to the second signal pattern separately, as for example in Figure 2, or together by merging the signals, as for example Figure 3. Different peaks in the strength of the signals are observed at various points along the surface of the scanned device. These points correspond to high points, which are detected at one depth of focus, and low points which are detected at the other depth of focus. Between the high points and the low points, intermediate signals are detected, which correspond to the width of the region between the high points and the low points, *e.g.,* the taper of a surface feature. By measuring the width of the signal corresponding to the high points and low points, the distance between the high points and low points, and the width of the intermediate signals, one is able to readily reconstruct the surface topology of the device corresponding to the features detected at the first and second depths of focus. Multiple scans at multiple depths of focus allows reconstruction of the surface features at multiple depths and allow measurement of the height of surface protrusions as well as the depth of surface depressions. A representation of the device corresponding to the detected surface features is then constructed and displayed.

Todokoro does not teach or suggest focusing an electron beam *to a first depth and a second depth* nor teach forming a representation of the device *corresponding to electrons focused at the first and second depths of focus and impinging on one or more <u>surfaces</u>* of the semiconductor device. In addition, as the Examiner acknowledges, Todokoro does not teach using multiple electron sources to obtain surface data from multiple depths of focus. Todokoro, in-fact, <u>does not disclose</u> multiple depths of focus at all. To the contrary, Todokoro teaches use of high energy electron beams to <u>penetrate beneath the surface</u> of the device to emit secondary electrons from the interior thereof, some of which are emitted on a path above the device, and some of which are emitted on a path below the device. The device is scanned by the penetrating electron beam, and in some embodiments with beams of different energies (to penetrate to different depths) or with beams at different angles to provide complex emission data that is synthesized into a tomographic or three dimensional image.

In this regard the Examiner is not correct in stating that col. 3, lines 55-59, of Todokoro discloses focusing the electron beam to a first focus depth and second depth. The term "depth of focus" is not used anywhere in the text, nor is there any concept therein that one of ordinary skill in the art would equate with depth of focus. The text cited by the Examiner discloses that:

> In another embodiment, at least one of tomographic and three-dimensional images is formed on the basis of a plurality of specimen images observed with two or more <u>particle beams which are different from each other in at least one of incident energy and angle</u>.

One of ordinary skill in the art would not equate different incident energies or angles with different depths of focus because the concepts are entirely different, require different equipment and produce different results.

Depth of focus relates to the depth of convergence (distance to the focal point) of the beam with respect to the position of the objective lens. This is accomplished by changing the convergence power of the objective lens or by changing the distance of the specimen with respect to the objective lens. Data obtained from different depths of focus therefore corresponds to the secondary electrons emitted from *surface* features observed at the different depths of focus. In contrast, incident energy relates to the power of the electron beam. This is accomplished by changing the power output of the source. Data obtained using different

energies relates to the secondary electrons emitted from *the interior of* the device in response to the different energies of the beam, whether or not the beam is set at the same depth of focus. Incident angle relates to the angular position of the specimen relative to the axis of the beam. This is accomplished by tilting the position of the specimen relative to the beam. Data obtained using different incident angles relates to the secondary electrons emitted as a result of changing the perspective of the specimen with respect to the beam, whether or not the beam is at the same plane of focus. Thus, Todokoro does not teach the concept of using different depths of focus.

Moreover, in changing the energy of the electron beam, Todokoro teaches away from changing the depth of focus. In fact, Todokoro teaches the opposite, which is that the focusing be adjusted to obtain the same field of view when the particle energy is changed:

> a thirteenth step is for performing at least one of the change of irradiation energy of the particle beam, particle adjustment such as focusing needed upon the change of irradiation energy and <u>insuring the same field of view upon the change of irradiation energy</u> col. 5, ln 3-7

Insuring the same field of view is contrary to using different depths of focus because insuring the same field of view <u>requires</u> the same depth of focus.

Applicants' disclosed embodiments, which detect surface emissions from beams at different depths of focus is advantageous over the system described by Todokoro, at least in part, because less sophisticated instrumentation is required to convert the data into a useable representation of surface topography as exemplified in Figures 2 and 3 of Applicants' specification. Applicants' embodiments can therefore be readily adapted to conventional scanning electron microscope equipment, which typically includes a variable focus objective lens. In contrast, the system disclosed by Todokoro based on detecting emissions from within the interior of the device using penetrating electron beams that may be of different energies and/or of different incident angles requires rather sophisticated computational methods and specialized equipment. (*e.g., see* Figures 5, 7-9, 12 and 13 to Todokoro). The methods described by Todokoro are akin to a CAT scan or an MRI in terms of the computational requirements needed to produce tomographic or three dimensional images based on the measurements taken.

Accordingly, Todokoro fails to teach or suggest the central feature of Applicants' disclosed embodiments, which is detection of signals received by scanning surfaces at multiple depths of focus. This deficiency is not cured by Iino, or the *Hitachi Technical Data*. Assuming

arguendo, that there is a teaching or suggestion to combine Iino with Todokoro, the combination would not lead one of ordinary skill in the art to Applicants' embodiments because Iino at most discloses a moveable XYZ stage for holding an electron microscope specimen. Similarly, the *Hitachi Technical Data* at most discloses an optical microscope configured with an electron microscope platform to observe a specimen mounted on the platform. No combination of the cited art would suggest combining data taken at multiple depths of focus with an XYZ stage or an optical microscope mounted with an electron microscope stage.

Turning now to the claims, base claim 1 recites in pertinent part, focusing the electron beam *to have a first depth and a second depth of focus and forming at least one representation of the semiconductor device corresponding to electrons focused at the first and second depths of focus and impinging on one or more* *<u>surfaces</u>* of the semiconductor device. As mentioned above, Todokoro teaches using penetrating electron beams to go beneath the surface and altogether fails to disclose different the depths of focus. Instead, Todokoro teaches using different beam energies and even there, teaches away from different depths of focus by teaching that the focus should be adjusted when the beam energy is changed to insure the same field, which requires the <u>same</u> depth of focus.

Base claim 12 recites in pertinent part, a first focusing device....*to focus the first electron beam on a first position* *<u>surface</u>* *along with a second focusing device*...to *focus the second electron beam on a second position* *<u>surface</u>* *that is different from the first position.* Todokoro fails to disclose first and second focusing devices and first and second electron beams for focusing on different surface positions. Again, Todokoro teaches different beam energies for penetrating beneath the surface. In this respect, Applicants respectfully submit the Examiner is not correct at page 5 of the Office Action in stating that the claims fail to distinguish over Todokoro's teaching of "detection of secondary or reflected electrons, which have penetrated the semiconductor device." It is submitted that the recited elements make it clear that the detected electrons are from the first and second position *<u>surfaces</u>* of the semiconductor, since these are the targets of the first and second focus.

Similarly, base claim 20 recites in pertinent part, *first and second sources of electrons,* a *first focusing device...to focus a first electron beam emitted from the first source on a first position* *<u>surface</u>*, and a *second focusing device...to focus a second electron beam emitted*

from the second source on a second position *surface*. As mentioned above, the first and second electron sources mentioned by Todokoro at the text cited by the Examiner are for providing different incident energies of penetrating electron beams, not for focusing at first and second surface positions.

Applicants respectfully submit that each of base claims 1, 12 and 20 are patentable over the cited art. The remaining dependent claims 2-11, 13-19 and 21-27 depend from an allowable base claim and are patentable at least on this ground. This is not, however, an admission that the patentability of these dependent claims rises and falls with patentability of the independent claims. Applicants submit that the dependent claims are patentable on separate grounds as well. In the interest of brevity, Applicants decline to comment on these separate grounds at the present time, but reserve the right to further discuss these grounds in the future. Accordingly, Applicants request the Examiner to withdraw the rejections of all claims under § 103.

With respect to the rejections under § 112, second paragraph, claims 6-8, 17-19 and 25-27 have been amended to recite the referenced detectors with proper antecedent basis. Therefore, Applicants request that the rejection of these claims on this ground also be withdrawn.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "**Version with Markings to Show Changes Made**".

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

DORSEY & WHITNEY LLP

Mark W. Roberts, Ph.D.
Registration No. 46,160

MWR:sj

Enclosures:
- Postcard
- Check
- Fee Transmittal Sheet (+ copy)
- Petition to Revive under 37 C.F.R. § 1.137(b)
- Declaration in Support of Petition
- Appointment of Associate Power of Attorney

1420 Fifth Avenue, Suite 3400
Seattle, WA 98101-4010
(206) 903-8800 (telephone)
(206) 903-8820 (fax)

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

6. (Amended) The apparatus of claim 5, further comprising a memory device coupled to at least one of the first, second and third detectors to store the signal generated by the at least one detector.

7. (Amended) The apparatus of claim 5, further comprising a display coupled to at least one of the first, second and third [the] detectors to graphically display a voltage generated by the first and second electron flows as a function of the movement detected by the third detector.

8. (Amended) The apparatus of claim 5, further comprising a printing device coupled to at least one of the first, second and third [the] detectors to print a representation of a voltage generated by the first and second flows of electrons as a function of the movement detected by the third sensor.

17. (Amended) The apparatus of claim 16, further comprising a memory device coupled to at least one of the first, second and third detectors to store the signal generated by the at least one detector.

18. Amended) The apparatus of claim 16, further comprising a display coupled to at least one of the first, second and third [the] detectors to graphically display a voltage generated by the first and second electron flows as a function of the movement detected by the third detector.

19. (Amended) The apparatus of claim 16, further comprising a printing device coupled to at least one of the first, second and third [the] detectors to print a representation of a voltage generated by the first and second flows of electrons as a function of the movement detected by the third sensor.

25. (Amended) The apparatus of claim 24, further comprising a memory device coupled to at least one of the first, second and third detectors to store the signal generated by the at least one detector.

26. (Amended) The apparatus of claim 24, further comprising a display coupled to at least one of the first, second and third [the] detectors to graphically display a strength of the first and second electron flows as a function of the movement detected by the third detector.

27. (Amended) The apparatus of claim 24, further comprising a printing device coupled to at least one of the first, second and third [the] detectors to print a representation of a strength of the first and second flows of electrons as a function of the movement detected by the third detector.